CORRESPONDENCE/MEMORANDUM

State of Wisconsin

DATE: January 6, 2022

TO: Sheri Snowbank – NOR/Spooner Service Center

FROM: Michael Polkinghorn – NOR/Rhinelander Service Center

SUBJECT: Water Quality-Based Effluent Limitations for the City of Ladysmith
WPDES Permit No. WI-0021326-11-0

This is in response to your request for an evaluation of the need for water quality-based effluent limitations (WQBELs) using chapters NR 102, 104, 105, 106, 207, 210, 212, and 217 of the Wisconsin Administrative Code (where applicable), for the discharge from the City of Ladysmith in Rusk County. This municipal wastewater treatment facility (WWTF) discharges to the Port Arthur Flowage of the Flambeau River, located in the Lower Flambeau River Watershed in the Upper Chippewa River Basin. The evaluation of the permit recommendations is discussed in more detail in the attached report.

Based on our review, the following recommendations are made on a chemical-specific basis at Outfall 001:

Parameter	Daily Maximum	Daily Minimum	Weekly Average	Monthly Average	Footnotes
Flow Rate					1, 2
BOD_5			45 mg/L	30 mg/L	2
TSS			45 mg/L	30 mg/L	2
pH	9.0 s.u.	6.0 s.u.			2
E. coli May – September				126 #/100 mL geometric mean	3
Ammonia Nitrogen	Variable		**108 mg/L**	**108 mg/L**	4, 5
Phosphorus				1.0 mg/L 4.7 lbs/day	6
Copper (Total Recoverable)					7
TKN, Nitrate+Nitrite, and Total Nitrogen					8
Acute WET					9

Footnotes:

1. Monitoring only.
2. No changes from the current permit.
3. Additional final limit: No more than 10 percent of *E. coli* bacteria samples collected in any calendar month may exceed 410 count/100 mL.
4. The variable daily maximum ammonia nitrogen limit table corresponding to various effluent pH values may be included in the permit in place of the single limit of 25 mg/L. These limits apply year-round.

Daily Maximum Ammonia Nitrogen Limits

Effluent pH s.u.	Limit mg/L	Effluent pH s.u.	Limit mg/L	Effluent pH s.u.	Limit mg/L
$6.0 \leq pH \leq 6.1$	108	$7.0 < pH \leq 7.1$	66	$8.0 < pH \leq 8.1$	14

6.1 < pH ≤ 6.2	106	7.1 < pH ≤ 7.2	59	8.1 < pH ≤ 8.2	11
6.2 < pH ≤ 6.3	104	7.2 < pH ≤ 7.3	52	8.2 < pH ≤ 8.3	9.4
6.3 < pH ≤ 6.4	101	7.3 < pH ≤ 7.4	46	8.3 < pH ≤ 8.4	7.8
6.4 < pH ≤ 6.5	98	7.4 < pH ≤ 7.5	40	8.4 < pH ≤ 8.5	6.4
6.5 < pH ≤ 6.6	94	7.5 < pH ≤ 7.6	34	8.5 < pH ≤ 8.6	5.3
6.6 < pH ≤ 6.7	89	7.6 < pH ≤ 7.7	29	8.6 < pH ≤ 8.7	4.4
6.7 < pH ≤ 6.8	84	7.7 < pH ≤ 7.8	24	8.7 < pH ≤ 8.8	3.7
6.8 < pH ≤ 6.9	78	7.8 < pH ≤ 7.9	20	8.8 < pH ≤ 8.9	3.1
6.9 < pH ≤ 7.0	72	7.9 < pH ≤ 8.0	17	8.9 < pH ≤ 9.0	2.6

5. Additional limits to comply with the expression of limits requirements in ss. NR 106.07 and NR 205.065(7), Wis. Adm. Codes, are included in bold.
6. The concentration limit is a technology-based effluent limit (TBEL) as described in s. 217.04(1)(a)1, Wis. Adm. Code. The mass limit is required as described in s. 217.14(1), Wis. Adm. Code, for the protection of downstream phosphorus impaired surface waters, and is based on the TBEL.
7. Monthly monitoring for 1 year is recommended during the reissued permit term to determine the need for copper limits at the next permit issuance.
8. As recommended in the Department's October 1, 2019, document titled *Guidance for Total Nitrogen Monitoring in Wastewater Permits*, annual total nitrogen monitoring is recommended for all minor municipal permittees. Total Nitrogen is the sum of nitrate (NO_3), nitrite (NO_2), and total Kjeldahl nitrogen (TKN) (all expressed as N).
9. Two acute whole effluent toxicity (WET) tests are recommended during the reissued permit term. According to the *State of Wisconsin Aquatic Life Toxicity Testing Methods Manual* (s. NR 219.04, Table A, Wis. Adm. Code), a synthetic (standard) laboratory water may be used as the dilution water and primary control in acute WET tests. Sampling WET concurrently with any chemical-specific toxic substances is recommended. Tests should be done in rotating quarters, to collect seasonal information about this discharge and should continue after the permit expiration date (until the permit is reissued).

Please consult the attached report for details regarding the above recommendations. If there are any questions or comments, please contact Michael Polkinghorn at (715) 360-3379 or Michael.Polkinghorn@wisconsin.gov and Diane Figiel at Diane.Figiel@wisconsin.gov.

Attachments (3) – Narrative, discharge area map, & weekly/monthly average ammonia nitrogen limit calculations

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Diane Figiel, P.E., Water Resources Engineer – WY/3

Attachment #1

Water Quality-Based Effluent Limitations for
City of Ladysmith

WPDES Permit No. WI-0021326-11-0

Prepared by: Michael A. Polkinghorn, E.I.T.

PART 1 – BACKGROUND INFORMATION

Facility Description

The City of Ladysmith owns and operates a domestic wastewater treatment system. Treatment begins with a fine bar screen for debris removal. Flow proceeds to two aerated lagoons operated in series where microorganisms in the wastewater breakdown organic matter. The second lagoon is separated by a baffle curtain to create a quiescent settling zone. Ferric chloride and sulfuric acid are added for chemical phosphorus removal and pH adjustment respectively. Wastewater proceeds to a disinfection step utilizing ultraviolet lights seasonally from May – September. Effluent is discharged on a continuous basis via Outfall 001 to the south bank of the Port Arthur Flowage of the Flambeau River, approximately 0.33 mi downstream of the County Highway G Bridge.

Attachment #2 is a discharge area map of Outfall 001.

Existing Permit Limitations

The current permit, expiring on 03/31/2022, includes the following effluent limitations and monitoring requirements.

Parameter	Daily Maximum	Daily Minimum	Weekly Average	Monthly Average	Footnotes
Flow Rate					1
BOD_5			45 mg/L	30 mg/L	2
TSS			45 mg/L	30 mg/L	2
pH	9.0 s.u.	6.0 s.u.			2
Fecal Coliform May – September			**656#/100 mL geometric mean**	400#/100 mL geometric mean	3
Ammonia Nitrogen	Variable		**110 mg/L**	**110 mg/L**	3, 4
Phosphorus				1.8 mg/L 8.5 lbs/day	5

Footnotes:

1. Monitoring only.
2. These limitations are not being evaluated as part of this review. Because the water quality criteria (WQC), reference effluent flow rates, and receiving water characteristics have not changed, limitations for these water quality characteristics do not need to be re-evaluated at this time.
3. Additional limits to comply with the expression of limits requirements in ss. NR 106.07 and NR 205.065(7), Wis. Adm. Codes, are included in bold.

4. The variable daily maximum ammonia nitrogen limit table corresponding to various effluent pH values may be included in the permit in place of the single limit. These limits apply year-round.

Daily Maximum Ammonia Nitrogen Limits

Effluent pH - s.u.	NH_3-N Limit – mg/L	Effluent pH - s.u.	NH_3-N Limit – mg/L	Effluent pH - s.u.	NH_3-N Limit – mg/L
5.9 < pH ≤ 6.0	110	7.0 < pH ≤ 7.1	66	8.0 < pH ≤ 8.1	14
6.0 < pH ≤ 6.1	108	7.1 < pH ≤ 7.2	59	8.1 < pH ≤ 8.2	11
6.1 < pH ≤ 6.2	106	7.2 < pH ≤ 7.3	52	8.2 < pH ≤ 8.3	9.4
6.2 < pH ≤ 6.3	104	7.3 < pH ≤ 7.4	46	8.3 < pH ≤ 8.4	7.8
6.3 < pH ≤ 6.4	101	7.4 < pH ≤ 7.5	40	8.4 < pH ≤ 8.5	6.4
6.4 < pH ≤ 6.5	98	7.5 < pH ≤ 7.6	34	8.5 < pH ≤ 8.6	5.3
6.5 < pH ≤ 6.6	94	7.6 < pH ≤ 7.7	29	8.6 < pH ≤ 8.7	4.4
6.6 < pH ≤ 6.7	89	7.7 < pH ≤ 7.8	24	8.7 < pH ≤ 8.8	3.7
6.7 < pH ≤ 6.8	84	7.8 < pH ≤ 7.9	20	8.8 < pH ≤ 8.9	3.1
6.8 < pH ≤ 6.9	78	7.9 < pH ≤ 8.0	17	8.9 < pH ≤ 9.0	2.6
6.9 < pH ≤ 7.0	72				

5. The concentration limit is a technology-based effluent limit (TBEL) as described in s. 217.04(2)(a)1, Wis. Adm. Code. The mass limit is required as described in s. 217.14(1), Wis. Adm. Code, for the protection of downstream phosphorus impaired surface waters, and is based on the TBEL. There is also a compliance schedule in the permit to determine if the facility can meet the TBEL of 1.0 mg/L by permit reissuance.

Receiving Water Information

- Name: Port Arthur Flowage of the Flambeau River
- Waterbody Identification Code (WBIC): Port Arthur Flowage (3000625) and Flambeau River (2225000).
- Classification used in accordance with chs. NR 102 and 104, Wis. Adm. Code: Warm Water Sport Fish (WWSF) community, non-public water supply.
- Low flows used in accordance with chs. NR 106 and 217, Wis. Adm. Code: The following 7-Q_{10} and 7-Q_2 values are from USGS for Station UC10 or the south half of Section 35, T36N – R5W, at Big Falls power plant, approximately 8.5 mi NE of Ladysmith, WI. This is approximately 15 mi upstream of Outfall 001.

  7-day Q_{10} = 412 cubic feet per second (cfs)
  7-day Q_2 = 709 cfs
  Harmonic Mean Flow = 862 cfs using a drainage area of 1,790 mi^2

  The Harmonic Mean has been estimated based on average flow and the 7-Q_{10} using an equation from U.S. EPA's *Technical Support Document for Water Quality-Based Toxics Control* (March 1991, EPA/505/2-90-001, pgs. 88-89).
- Hardness = 38 mg/L as $CaCO_3$. This value represents the geometric mean of background data (n =11) for the Flambeau River in Ladysmith, WI from January 1988 – June 2015.
- % of low flow used to calculate limits in accordance with s. NR 106.06(4)(c)5., Wis. Adm. Code: 25%.
- Source of background concentration data: Metals data from the Flambeau River near Ladysmith, WI is used for this evaluation. The numerical values are shown in the tables below in Part 2 of this

evaluation. If no data is available, the background concentration is assumed to be negligible and a value of zero is used in the computations. Background data for calculating effluent limitations for ammonia nitrogen and phosphorus are described later.

- Multiple dischargers: Dunn Paper – Ladysmith, LLC discharges approximately 1.1 mi upstream of Outfall 001. This discharge is included in calculation of the phosphorus WQBEL for the City of Ladysmith and is described more in Part 5 of this evaluation.
- Impaired water status: None at receiving water. The Holcombe Flowage is approximately 25 mi downstream of Outfall 001 and is on the Clean Water Act (CWA) Section 303(d) list for eutrophication, degraded habitat, and elevated pH. The pollutants of the impairment are phosphorus, TSS, and mercury. Lake Wissota is approximately 54 mi downstream of Outfall 001 and is also on the CWA Section 303(d) list for excess algal growth and polychlorinated biphenyls (PCBs) contaminated fish tissue. The pollutants of the impairment are PCBs, phosphorus, and mercury.

Effluent Information

- Design flow rate(s):
  Annual average = 0.565 Million Gallons per Day (MGD)
  For reference, the actual average flow from April 2017 – October 2021 was 0.419 MGD.
- Hardness = 167 mg/L as $CaCO_3$. This value represents the geometric mean of data (n = 4) from the permit application required monitoring during May 2021.
- Acute dilution factor used in accordance with s. NR 106.06(3)(c), Wis. Adm. Code: Not applicable – this facility does not have an approved zone of initial dilution (ZID).
- Water source: Domestic wastewater with no industrial contributors.
- Water supply: City of Ladysmith.
- Additives: Ferric chloride for chemical phosphorus removal and sulfuric acid for pH adjustment.
- Effluent characterization: This facility is categorized as a minor municipality, so the permit application required effluent sample analyses for a limited number of common pollutants, as specified in s. NR 200.065, Table 1, Wis. Adm. Code, primarily metal substances plus chloride and hardness.
- Effluent data for substances for which a single sample was analyzed is shown in the tables in Part 2 below, in the columns titled "MEAN EFFL. CONC.". Otherwise, substances with multiple effluent data are shown in the tables below or in their respective parts in this evaluation.

Copper Effluent Data

Sample Date	µg/L	Sample Date	µg/L	Sample Date	µg/L
05/04/2021	22	05/18/2021	18	06/05/2021	20
05/07/2021	18	05/21/2021	18	06/08/2021	18
05/11/2021	17	05/25/2021	17	06/11/2021	16
05/14/2021	17	06/02/2021	24		
1-day P_{99} = 25 µg/L					
4-day P_{99} = 22 µg/L					

Chloride Effluent Data

Sample Date	mg/L
05/04/2021	160
05/07/2021	160
05/11/2021	160
05/14/2021	160

Attachment #1

Sample Date	mg/L
Mean	160

The following table presents the average concentrations and loadings at Outfall 001 from April 2017 – October 2021 for all parameters with limits in the current permit to meet the requirements of s. NR 201.03(6), Wis. Adm. Code:

Parameter Averages with Limits

	Average Measurement*	Average Mass Discharged
BOD_5	11.9 mg/L	
TSS	9.9 mg/L	
pH field	7.25 s.u.	
Fecal Coliform	1.1 #/100 mL	
Ammonia Nitrogen	19.9 mg/L	
Phosphorus	1.00 mg/L	3.40 lbs/day

*Results below the level of detection (LOD) were included as zeroes in calculation of average.

PART 2 – WATER QUALITY-BASED EFFLUENT LIMITATIONS FOR TOXIC SUBSTANCES – EXCEPT AMMONIA NITROGEN

Permit limits for toxic substances are required whenever any of the following occur:

1. The maximum effluent concentration exceeds the calculated limit (s. NR 106.05(3), Wis. Adm. Code)
2. If 11 or more detected results are available in the effluent, the upper 99th percentile (or P_{99}) value exceeds the comparable calculated limit (s. NR 106.05(4), Wis. Adm. Code)
3. If fewer than 11 detected results are available, the mean effluent concentration exceeds 1/5 of the calculated limit (s. NR 106.05(6), Wis. Adm. Code)

Acute Limits based on 1-Q_{10}

Daily maximum effluent limitations for toxic substances are based on the acute toxicity criteria (ATC), listed in ch. NR 105, Wis. Adm. Code. Previously daily maximum limits for toxic substances were calculated as two times the ATC. However, changes to ch. NR 106, Wis. Adm. Code, (September 1, 2016) require the Department to calculate acute limitations using the same mass balance equation as used for other limits along with the 1-Q_{10} receiving water low flow to determine if more restrictive effluent limitations are needed to protect the receiving stream from discharges which may cause or contribute to an exceedance of the acute water quality standards. The mass balance equation is provided below:

$$\text{Limitation} = \frac{(WQC)\,(Qs + (1-f)\,Qe) - (Qs - f\,Qe)\,(Cs)}{Qe}$$

Where:

WQC =Acute toxicity criterion or secondary acute value according to ch. NR 105, Wis. Adm. Code.

Qs = average minimum 1-day flow which occurs once in 10 years (1-day Q_{10}) if the 1-day Q_{10} flow data is not available = 80% of the average minimum 7-day flow which occurs once in 10 years (7-day Q_{10}).

Qe = Effluent flow (in units of volume per unit time) as specified in s. NR 106.06(4)(d), Wis. Adm. Code.
f = Fraction of the effluent flow that is withdrawn from the receiving water, and
Cs = Background concentration of the substance (in units of mass per unit volume) as specified in s. NR 106.06(4)(e), Wis. Adm. Code.

If the receiving water is effluent dominated under low stream flow conditions, the 1-Q_{10} method of limit calculation produces the most stringent daily maximum limitations and should be used while making reasonable potential determinations. This is not the case for City of Ladysmith and the limits are set based on two times the ATC.

The following tables list the calculated WQBELs for this discharge along with the results of effluent sampling. All concentrations are expressed in terms of micrograms per liter (µg/L), except for hardness and chloride which are expressed in mg/L.

Daily Maximum Limits based on Acute Toxicity Criteria (ATC)
RECEIVING WATER FLOW = 330 cfs, (1-Q_{10} (estimated as 80% of 7-Q_{10})), as specified in s. NR 106.06(3)(bm), Wis. Adm. Code.

SUBSTANCE	REF. HARD. mg/L	ATC	MAX. EFFL. LIMIT*	1/5 OF EFFL. LIMIT	MEAN EFFL. CONC.	1-day P_{99}	1-day MAX. CONC.
Arsenic		340	680	136	<0.85		<0.85
Cadmium	167	18.6	37.2	7.4	<0.19		<0.19
Chromium (+3)	167	2,750	5,500	1,100	1.2		1.2
Copper	167	25.2	50.5			25	24
Lead	167	176	352	70.4	<4.3		<4.3
Nickel	167	726	1,451	290	6.9		6.9
Zinc	167	189	378	75.6	17		17
Chloride (mg/L)		757	1,514	303	160		160

* The 2 × ATC method of limit calculation yields a more restrictive limit than consideration of ambient concentrations and 1-Q_{10} flow rates per the changes to s. NR 106.07(3), Wis. Adm. Code, effective 09/01/2016.

Weekly Average Limits based on Chronic Toxicity Criteria (CTC)
RECEIVING WATER FLOW = 103 cfs (¼ of the 7-Q_{10}), as specified in s. NR 106.06(4)(c), Wis. Adm. Code

SUBSTANCE	REF. HARD. mg/L	CTC	MEAN BACK-GRD.	WEEKLY AVE. LIMIT	1/5 OF EFFL. LIMIT	MEAN EFFL. CONC.	4-day P_{99}
Arsenic		152	0.49	18,027	3,605	<0.85	
Cadmium	38	1.15	0.316	99.4	19.9	<0.19	
Chromium (+3)	38	59.8	0.242	7,078	1,416	1.2	
Copper	38	4.52	0.65	460.5			22
Lead	38	11	0.227	1,280	256	<4.3	
Nickel	38	23.0	0.759	2,646	529	6.9	
Zinc	38	51.7	1.39	5,973	1,195	17	
Chloride (mg/L)		395		46,934	9,387	160	

Monthly Average Limits based on Wildlife Criteria (WC)

The effluent characterization did not include any effluent sampling results for substances for which WC exist.

Monthly Average Limits based on Human Threshold Criteria (HTC)

RECEIVING WATER FLOW = 216 cfs (¼ of Harmonic Mean), as specified in s. NR 106.06(4), Wis. Adm. Code.

SUBSTANCE	HTC	MEAN BACK-GRD.	MO'LY AVE. LIMIT	1/5 OF EFFL. LIMIT	MEAN EFFL. CONC.
Cadmium	370	0.316	91,521	18,304	<0.19
Chromium (+3)	3,818,000	0.242	945,202,412	189,040,482	1.2
Lead	140	0.227	34,603	6,921	<4.3
Nickel	43,000	0.759	10,645,100	2,129,020	6.9

Monthly Average Limits based on Human Cancer Criteria (HCC)

RECEIVING WATER FLOW = 216 cfs (¼ of Harmonic Mean), as specified in s. NR 106.06(4), Wis. Adm. Code.

SUBSTANCE	HCC	MEAN BACK-GRD.	MO'LY AVE. LIMIT	1/5 OF EFFL. LIMIT	MEAN EFFL. CONC.
Arsenic	13.3	0.49	3,172	634	<0.85

In addition to evaluating the need for limits for each individual substance for which HCC exist, s. NR 106.06(8), Wis. Adm. Code, requires the evaluation of the cumulative cancer risk. Because no effluent limits are needed based on HCC, determination of the cumulative cancer risk is not needed per s. NR 106.06(8), Wis. Adm. Code.

Conclusions and Recommendations

Based on a comparison of the effluent data and calculated effluent limitations, **effluent limitations are not recommended for any toxic substances.** The need for ammonia nitrogen limits is evaluated in Part 3 of this evaluation. Monitoring recommendations are made in the following paragraphs:

Copper – Considering available effluent data from the current permit term (May 2021 – June 2021), the 1-day and 4-day P_{99} concentrations are 25 and 22 µg/L respectively. These effluent concentrations are below the calculated WQBELs for copper. Therefore, no copper limits are recommended during the reissued permit term. In this case, the lack of 11 detect copper samples would most likely result in the need for a daily maximum limit in subsequent permits when the $1/5^{th}$ of the limit versus the mean effluent concentration is used. Therefore, **monthly monitoring for 1 year is recommended during the reissued permit term to determine the need for copper limits at the next permit issuance.**

Mercury – The permit application did not require monitoring for mercury because City of Ladysmith is categorized as a minor facility as defined in s. NR 200.02(8), Wis. Adm. Code. In accordance with s. NR 106.145(3)(a)3, Wis. Adm. Code, a minor municipal discharger shall monitor, and report results of influent and effluent mercury monitoring once every three months if, "there are two or more exceedances in the last five years of the high-quality sludge mercury concentration of 17 mg/kg specified in s. NR 204.07(5), Wis. Adm. Code." However, sludge sampling is not available because the City of Ladysmith is an aerated lagoon system and does not dispose its sludge via land application. This facility does not generate sludge for monitoring, other similar municipalities do not have mercury exceedance issues, and

there are no industrial contributions. **Therefore, limits or monitoring for mercury are not recommended during the reissued permit term.**

PART 3 – WATER QUALITY-BASED EFFLUENT LIMITATIONS FOR AMMONIA NITROGEN

The State of Wisconsin promulgated revised water quality standards for ammonia nitrogen in ch. NR 105, Wis. Adm. Code, effective March 1, 2004, which includes criteria based on both acute and chronic toxicity to aquatic life. The current permit has year round daily maximum, weekly average and monthly average limits. These limits are re-evaluated at this time due to the following changes:

- Subchapter IV of ch. NR 106, Wis. Adm. Code allows limits based on available dilution instead of limits set to twice the acute criteria.
- Section NR 106.07(3), Wis. Adm. Code, requires weekly and monthly average limits for municipal treatment plants.

Daily Maximum Limits based on Acute Toxicity Criteria (ATC)
Daily maximum limitations are based on ATC in ch. NR 105, Wis. Adm. Code, which are a function of the effluent pH and the receiving water classification. The ATC for ammonia is calculated using the following equation:

$$\text{ATC in mg/L} = [A \div (1 + 10^{(7.204 - pH)})] + [B \div (1 + 10^{(pH - 7.204)})]$$

Where:

A = 0.411 and B = 58.4 for a WWSF community
pH (s.u.) = that characteristic of the effluent.

The effluent pH data was examined as part of this evaluation. A total of 1,188 sample results were reported from April 2017 – October 2021. The maximum reported value was 7.90 s.u. (standard units). The effluent pH was 7.70 s.u. or less 99% of the time. The 1-day P_{99}, calculated in accordance with s. NR 106.05(5), Wis. Adm. Code, is 7.78 s.u. The mean plus the standard deviation multiplied by a factor of 2.33, an estimate of the upper ninety ninth percentile for a normally distributed dataset, is 7.76 s.u. Therefore, a value of 7.78 s.u. is believed to represent the maximum reasonably expected pH, and therefore most appropriate for determining daily maximum limitations for ammonia nitrogen. Substituting a value of 7.78 s.u. into the equation above yields an ATC = 12.66 mg/L.

Potential Changes to Daily Maximum Ammonia Nitrogen Effluent Limitations
Subchapter IV of ch. NR 106, Wis. Adm. Code (effective September 1, 2016), specifies methods for the use of the 1-Q_{10} receiving water low flow to calculate daily maximum ammonia nitrogen limits if it is determined that the previous method of acute ammonia limit calculation (2×ATC) is not sufficiently protective of the fish and aquatic life. The more restrictive calculated limits shall apply.

The calculated daily maximum ammonia nitrogen effluent limits using the mass balance approach with the 1-Q_{10} (estimated as 80 % of 7-Q_{10}) and the 2×ATC approach are shown below.

Daily Maximum Ammonia Nitrogen Determination

Method	Ammonia Nitrogen Limit mg/L
2×ATC	25

1-Q_{10}	4,757

The 2×ATC method yields the most stringent limits for City of Ladysmith.

The current permit has variable daily maximum effluent limits based on effluent pH. Presented below is a table of daily maximum limitations corresponding to various effluent pH values.

Daily Maximum Ammonia Nitrogen Limits – WWSF

Effluent pH s.u.	Limit mg/L	Effluent pH s.u.	Limit mg/L	Effluent pH s.u.	Limit mg/L
6.0 ≤ pH ≤ 6.1	108	7.0 < pH ≤ 7.1	66	8.0 < pH ≤ 8.1	14
6.1 < pH ≤ 6.2	106	7.1 < pH ≤ 7.2	59	8.1 < pH ≤ 8.2	11
6.2 < pH ≤ 6.3	104	7.2 < pH ≤ 7.3	52	8.2 < pH ≤ 8.3	9.4
6.3 < pH ≤ 6.4	101	7.3 < pH ≤ 7.4	46	8.3 < pH ≤ 8.4	7.8
6.4 < pH ≤ 6.5	98	7.4 < pH ≤ 7.5	40	8.4 < pH ≤ 8.5	6.4
6.5 < pH ≤ 6.6	94	7.5 < pH ≤ 7.6	34	8.5 < pH ≤ 8.6	5.3
6.6 < pH ≤ 6.7	89	7.6 < pH ≤ 7.7	29	8.6 < pH ≤ 8.7	4.4
6.7 < pH ≤ 6.8	84	7.7 < pH ≤ 7.8	24	8.7 < pH ≤ 8.8	3.7
6.8 < pH ≤ 6.9	78	7.8 < pH ≤ 7.9	20	8.8 < pH ≤ 8.9	3.1
6.9 < pH ≤ 7.0	72	7.9 < pH ≤ 8.0	17	8.9 < pH ≤ 9.0	2.6

The variable daily maximum effluent limits table based on effluent pH in the current permit corresponds to a pH range of 5.9 – 9.0 s.u. The table is slightly adjusted to correspond to the pH range of 6.0 – 9.0 s.u. since the City of Ladysmith must be in compliance with the same pH limits in the current permit. **Therefore, the updated variable table above is recommended during the reissued permit term.**

Weekly and Monthly Average Limits based on Chronic Toxicity Criteria (CTC)
The weekly and monthly average ammonia nitrogen limits calculation from the previous WQBEL memorandum (May 2016) do not change because there have been no changes in the effluent and receiving water flow rates. The calculations from the previous evaluation are included as attachment #3.

Effluent Data & Reasonable Potential Analysis
The following table presents statistics based upon ammonia data reported from April 2017 – October 2021, with those results being compared to the calculated limits to determine the need to include ammonia limits in the City of Ladysmith permit for the respective month ranges. That need is determined by calculating 99th upper percentile (or P_{99}) values for ammonia during each of the month ranges and additionally comparing the daily maximum effluent values to the daily maximum limit.

Ammonia Nitrogen Effluent Data

Statistics mg/L	May – October	November – April
1-day P_{99}	60.0	61.8
4-day P_{99}	32.8	43.5
30-day P_{99}	18.2	34.0
Mean*	12.1	29.3
Std	12.2	10.5

Attachment #1

Sample size	130	107
Range	0.032 - 37.8	0.2 - 44.4

*Values lower than the level of detection were substituted with a zero

Based on this comparison, daily maximum limits are required year round. The permit currently has daily maximum, weekly average, and monthly average limits year round. **Where there are existing ammonia nitrogen limits in the permit, the limits must be retained regardless of reasonable potential**, consistent with s. NR 106.33(1)(b), Wis. Adm. Code:

> (b) If a permittee is subject to an ammonia limitation in an existing permit, the limitation shall be included in any reissued permit. Ammonia limitations shall be included in the permit if the permitted facility will be providing treatment for ammonia discharges.

Expression of Limits

Revisions to ch. NR 106, Wis. Adm. Code, in September 2016 aligned Wisconsin's WQBELs with 40 CFR § 122.45(d), which specifies that effluent limits for continuous dischargers must be expressed as weekly and monthly averages for publicly owned treatment works and as daily maximums and monthly averages for all other dischargers, unless shown to be impracticable. Because a daily maximum ammonia limit is necessary for City of Ladysmith, weekly and monthly average limits are also required under this code revision.

The methods for calculating limitations for municipal treatment facilities to conform to 40 CFR 122.45(d) are specified in s. NR 106.07(3), Wis. Adm. Code, and are as follows:

> Whenever a daily maximum limitation is determined necessary to protect water quality, a weekly and monthly average limitation shall also be included in the permit and set equal to the daily maximum limit unless a more restrictive limit is already determined necessary to protect water quality.

In this case, the recommended daily maximum limits vary with effluent pH, so additional limits should be set equal to the highest recommended limit. **Therefore, weekly and monthly average limits of 108 mg/L are recommended in the reissued permit.**

Conclusions and Recommendations

In summary, after rounding to two significant figures, the following ammonia nitrogen limitations are recommended. No mass limitations are recommended in accordance with s. NR 106.32(5), Wis. Adm Code. Additional limits to meet the requirements in s. NR 106.07, Wis. Adm Code, are included in bold.

Final Ammonia Nitrogen Limits

	Daily Maximum mg/L	Weekly Average mg/L	Monthly Average mg/L
Year round	Variable	**108**	**108**

PART 4 – WATER QUALITY-BASED EFFLUENT LIMITATIONS FOR BACTERIA

On May 1, 2020, revisions to chs. NR 102 and NR 210, Wis. Adm. Codes, became effective which replace fecal coliform limits with new *Escherichia coli* (*E. coli*) limits for protection of recreational uses. Section NR 210.06(2)(a)1, Wis. Adm. Code, includes two limits which must be included in permits for facilities which are required to disinfect:

1. The geometric mean of *E. coli* bacteria in effluent samples collected in any calendar month may not exceed 126 counts/100 mL.
2. No more than 10 percent of *E. coli* bacteria samples collected in any calendar month may exceed 410 counts/100 mL.

E. coli monitoring is recommended at the same frequency that fecal coliform monitoring is required in the current permit. Because the City of Ladysmith's permit requires weekly monitoring, the 410 counts/100 mL limit will effectively function as a daily maximum limit unless the facility performs additional monitoring. Any additional monitoring beyond what is required by the permit must also be reported on the DMR as required in the standard requirements section of the permit.

These limits are required during May – September. No changes are recommended to the current recreational period and the required disinfection season.

Effluent Data
The City of Ladysmith has monitored effluent *E. coli* from May 2021 – September 2021 and a total of 31 results are available. A geometric mean of 126 counts/100 mL was not exceeded, with a maximum monthly geometric mean of 3.3 counts/100 mL. Effluent data has never exceeded 410 counts/100 mL, with a maximum reported value of 21.8 counts/100 mL. **Based on this effluent data the facility can meet the new *E. coli* limits and a compliance schedule is not needed in the reissued permit.**

PART 5 – PHOSPHORUS

Technology-Based Effluent Limit
Subchapter II of Chapter NR 217, Wis. Adm. Code, requires municipal wastewater treatment facilities that discharge greater than 150 pounds of total phosphorus per month to comply with a monthly average limit of 1.0 mg/L, or an approved alternative concentration limit.

The following table summarizes effluent total phosphorus monitoring data from April 2017 – October 2021.

Total Phosphorus Effluent Data

	Phosphorus mg/L
1-day P_{99}	1.99
4-day P_{99}	1.44
30-day P_{99}	1.15
Mean	1.00
Std	0.32

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Sample size	112
Range	0.47 - 1.86

The City of Ladysmith exceeded the 150 lbs. per month threshold in a previous permit and has an alternative effluent limit (AEL) of 1.8 mg/L in the current permit as described in s. NR 217.04(2)(a)1, Wis. Adm. Code in place of the 1.0 mg/L, and was based on the fact that a 1.0 mg/L limit was not considered to be practically achievable for lagoon-based WWTFs. The City of Ladysmith completed an upgrade for chemical phosphorus treatment in 2015 and has a compliance schedule in the current permit to meet the TBEL of 1.0 mg/L by permit reissuance. They and their consultant stated in their final report for total phosphorus optimization (April 2021) that the facility can consistently meet the 1.0 mg/L limit. In addition, they also indicated in the permit application they would not be reapplying for the phosphorus AEL. A comparison of effluent monthly average phosphorus data against the 1.0 mg/L limit shows the facility would have been 53% compliant with the limit, i.e. 28 of the 55 available months during the current permit term were less than or equal to the limit. Among these months the facility has been consistently compliant (outside of April 2020) from April 2019 – November 2020 during the study period. **Therefore, the TBEL of 1.0 mg/L as a monthly average is recommended during the reissued permit term.**

In addition, the need for a WQBEL for phosphorus must be considered to assure protection of water quality.

Water Quality-Based Effluent Limits (WQBEL)
Revisions to administrative rules regulating phosphorus took effect on December 1, 2010. These rule revisions include additions to s. NR 102.06, Wis. Adm. Code, which established phosphorus standards for surface waters. Subchapter III of NR 217, Wis. Adm. Code, establishes procedures for determining WQBELs for phosphorus, based on the applicable standards in ch. NR 102, Wis. Adm. Code.

Section NR 102.06(3)(a), Wis. Adm. Code, specifically names river segments for which a phosphorus criterion of 0.100 mg/L applies. For other stream segments that are not specified in s. NR 102.06(3)(a), Wis. Adm. Code, s. NR 102.06(3)(b), Wis. Adm. Code, specifies a phosphorus criterion of 0.075 mg/L. The phosphorus criterion of 0.100 mg/L applies for the Port Arthur Flowage of the Flambeau River as described in s. 102.06(3)(a)13, Wis. Adm. Code.

The conservation of mass equation is described in s. NR 217.13(2)(a), Wis. Adm. Code, for phosphorus WQBELs and includes variables of WQC, receiving water flow rate (Qs), effluent flow rate (Qe), and upstream phosphorus concentrations (Cs) provided below.

$$\text{Limitation} = [(WQC)(Qs+(1-f)\ Qe) - (Qs-f\ Qe)\ (Cs)]/Qe$$

Where:

WQC = 0.100 mg/L
Qs = 100% of the 7-Q_2 of 709 cfs
Cs = background concentration of phosphorus in the receiving water pursuant to s. NR 217.13(2)(d), Wis. Adm. Code
Qe = effluent flow rate
f = the fraction of effluent withdrawn from the receiving water = 0

The effluent flow used in the previous WQBEL memorandum (May 2016) was the combined annual average flows from Outfall 001 of the City of Ladysmith and Outfall 001 of Cellu Tissue (now Dunn Paper – Ladysmith, LLC). The Q_e was 3.48 cfs using the sum of the old facility planning design flow of the City of Ladysmith (0.8 MGD = 1.24 cfs) and the overall average flow from Dunn Paper – Ladysmith, LLC (1.45 MGD = 2.25 cfs). This evaluation will continue the use of the combined discharge flows of both facilities because both discharges contain all the phosphorus loading from both facilities. The sum of the current annual average design flow of the City of Ladysmith (0.565 MGD = 0.876 cfs) and the maximum annual average flow of Dunn Paper – Ladysmith, LLC will be used to be consistent with limit evaluations for municipal and industrial discharges statewide respectively. The maximum annual average flow from Dunn Paper – Ladysmith, LLC is 1.10 MGD (1.70 cfs). This flowrate is representative of the October 2017 – October 2018 flow year evaluated from the April 2017 – October 2021 discharge monitoring reports dataset. Therefore, the representative Q_e is 0.876 + 1.70 = 2.58 cfs.

Section NR 217.13(2)(d), Wis. Adm. Code, specifies that the background phosphorus concentration used in the limit calculation formula shall equal the median of at least four samples collected during the months of May through October, and that all samples collected during a 28-day period shall be considered as a single sample and the average of these concentrations used to determine a median. Averaging begins at date of the first sample in the range of May through October.

A previous WQBEL memorandum (May 2016) resulted in a WQBEL of 14.1 mg/L using a background concentration of 0.0315 mg/L. This value is the calculated median background concentration of 16 samples collected from multiple stations in the Big Falls Flowage and the Dairyland Reservoir during the summers of 2005 – 2009. Section NR 217.13(2)(d), Wis. Adm. Code, states that the determination of upstream concentrations shall be evaluated at each permit reissuance. Additional data were considered in estimating the background phosphorus concentration.

A review of all available in stream total phosphorus data stored in the Surface Water Integrated Monitoring System database show there are no updated background values of phosphorus newer than 2009 for the Flambeau River upstream of Ladysmith, WI. Therefore, the background concentration of 0.0315 mg/L will continue to be utilized in this evaluation.

Substituting a median value of 0.0315 mg/L into the limit calculation equation above, the calculated limit is 19 mg/L as a monthly average. **Because the TBEL of 1.0 mg/L as a monthly average is significantly more stringent, the WQBEL is not recommended during the reissued permit term.**

Mass Limits

A mass limit is also required, pursuant to s. NR 217.14(1)(a) and (b), Wis. Adm. Codes, because the discharge is to a surface water that is to or upstream of phosphorus impaired surface waters. These surface waters include the Holcombe Flowage and Lake Wissota, both below the confluence of the Flambeau and Chippewa Rivers. **This final mass limit shall be 1.0 mg/L × 8.34 × 0.565 MGD = 4.7 lbs/day expressed as a monthly average during the reissued permit term.**

PART 6 – WATER QUALITY-BASED EFFLUENT LIMITATIONS FOR THERMAL

Surface water quality standards for temperature took effect on October 1, 2010. These regulations are detailed in chs. NR 102 (Subchapter II – Water Quality Standards for Temperature) and NR 106

(Subchapter V – Effluent Limitations for Temperature) of the Wisconsin Administrative Code. Daily maximum and weekly average temperature criteria are available for the 12 different months of the year depending on the receiving water classification.

Due to the amount of upstream flow available for dilution in the limit calculation (Qs:Qe >20:1), the lowest calculated limitation is 120° F (s. NR 106.55(6)(a), Wis. Adm. Code). At temperatures above approximately 103° F, conventional biological treatment systems do not function properly and experience upsets. There is no indication that this has ever occurred in this treatment system. There is no reasonable potential for the discharge to exceed this limit. **Therefore, limits or monitoring for temperature are not recommended during the reissued permit term.**

PART 7 – WHOLE EFFLUENT TOXICITY (WET)

WET testing is used to measure, predict, and control the discharge of toxic materials that may be harmful to aquatic life. In WET tests, organisms are exposed to a series of effluent concentrations for a given time and effects are recorded. Decisions below related to the selection of representative data and the need for WET limits were made according to ss. NR 106.08 and 106.09, Wis. Adm. Code. WET monitoring frequency and toxicity reduction evaluation (TRE) recommendations were made using the best professional judgment of staff familiar with the discharge after consideration of the guidance in the *Whole Effluent Toxicity (WET) Program Guidance Document (October 29, 2019).*

- Acute tests predict the concentration that causes lethality of aquatic organisms during a 48 to 96-hour exposure. To assure that a discharge is not acutely toxic to organisms in the receiving water, WET tests must produce a statistically valid LC_{50} (Lethal Concentration to 50% of the test organisms) greater than 100% effluent, according to s. NR 106.09(2)(b), Wis. Adm Code.

- Chronic testing is usually not recommended where the ratio of the 7-Q_{10} to the effluent flow exceeds 100:1. For the City of Ladysmith, that ratio is approximately 471:1. With this amount of dilution, there is believed to be little potential for chronic toxicity effects in the Port Arthur Flowage of the Flambeau River associated with the discharge from the City of Ladysmith. **Therefore, the need for chronic WET testing will not be considered further.**

- According to the *State of Wisconsin Aquatic Life Toxicity Testing Methods Manual* (s. NR 219.04, Table A, Wis. Adm. Code), a synthetic (standard) laboratory water may be used as the dilution water and primary control in acute WET tests, unless the use of different dilution water is approved by the Department prior to use. The primary control water must be specified in the WPDES permit.

- Shown below is a tabulation of all available WET data for Outfall 001. Efforts are made to ensure that decisions about WET monitoring and limits are made based on representative data, as specified in s. NR 106.08(3), Wis. Adm Code. Data which is not believed to be representative of the discharge was not included in reasonable potential calculations. The table below differentiates between tests used and not used when making WET determinations. Significant changes were made to WET test methods in 2004 and these changes were assumed to be fully implemented by certified labs by no later than June 2005. Therefore, tests conducted after June 2005 are shown in the table below.

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WET Data History

Date Test Initiated	Acute Results LC_{50} % (% survival in 100% effluent)				Footnotes or Comments
	C. dubia	Fathead minnow	Pass or Fail?	Used in RP?	
08/02/2005	>100	>100	Pass	Yes	
08/26/2008	>100	>100	Pass	Yes	
06/16/2009	>100	>100	Pass	Yes	
07/31/2012	>100	>100	Pass	Yes	
04/15/2014	>100	>100	Pass	Yes	

- According to s. NR 106.08, Wis. Adm. Code, WET reasonable potential is determined by multiplying the highest toxicity value that has been measured in the effluent by a safety factor, to predict the likelihood (95% probability) of toxicity occurring in the effluent above the applicable WET limit. The safety factor used in the equation changes based on the number of toxicity detects in the dataset. The fewer detects present, the higher the safety factor, because there is more uncertainty surrounding the predicted value. WET limits must be given, according to s. NR 106.08(6), Wis. Adm. Code, whenever the applicable Reasonable Potential equation results in a value greater than 1.0.

  Acute Reasonable Potential = [(TUa effluent) (B)(AMZ)]
  Chronic Reasonable Potential = [(TUc effluent) (B)(IWC)]

  According to s. NR 106.08(6)(d), Wis. Adm. Code, TUa and TUc effluent values are equal to zero whenever toxicity is not detected (i.e. when the LC_{50}, IC_{25} or $IC_{50} \geq 100\%$).

  Acute Reasonable Potential = 0 < 1.0, reasonable potential is not shown, and a limit is not required.

  Chronic Reasonable Potential: There are no chronic WET data available so reasonable potential cannot be determined at this time.

The WET checklist was developed to help DNR staff make recommendations regarding WET limits, monitoring, and other related permit conditions. The checklist indicates whether acute and chronic WET limits are needed, based on requirements specified in s. NR 106.08, Wis. Adm. Code. The checklist steps the user through a series of questions, assesses points based on the potential for effluent toxicity, and suggests monitoring frequencies based on points accumulated during the checklist analysis. As toxicity potential increases, more points accumulate, and more monitoring is recommended to ensure that toxicity is not occurring. A summary of the WET checklist analysis completed for this permittee is shown in the table below. Staff recommendations based on best professional judgment are provided below the summary table. For guidance related to reasonable potential and the WET checklist, see Chapter 1.3 of the WET Guidance Document: https://dnr.wisconsin.gov/topic/Wastewater/WET.html.

WET Checklist Summary

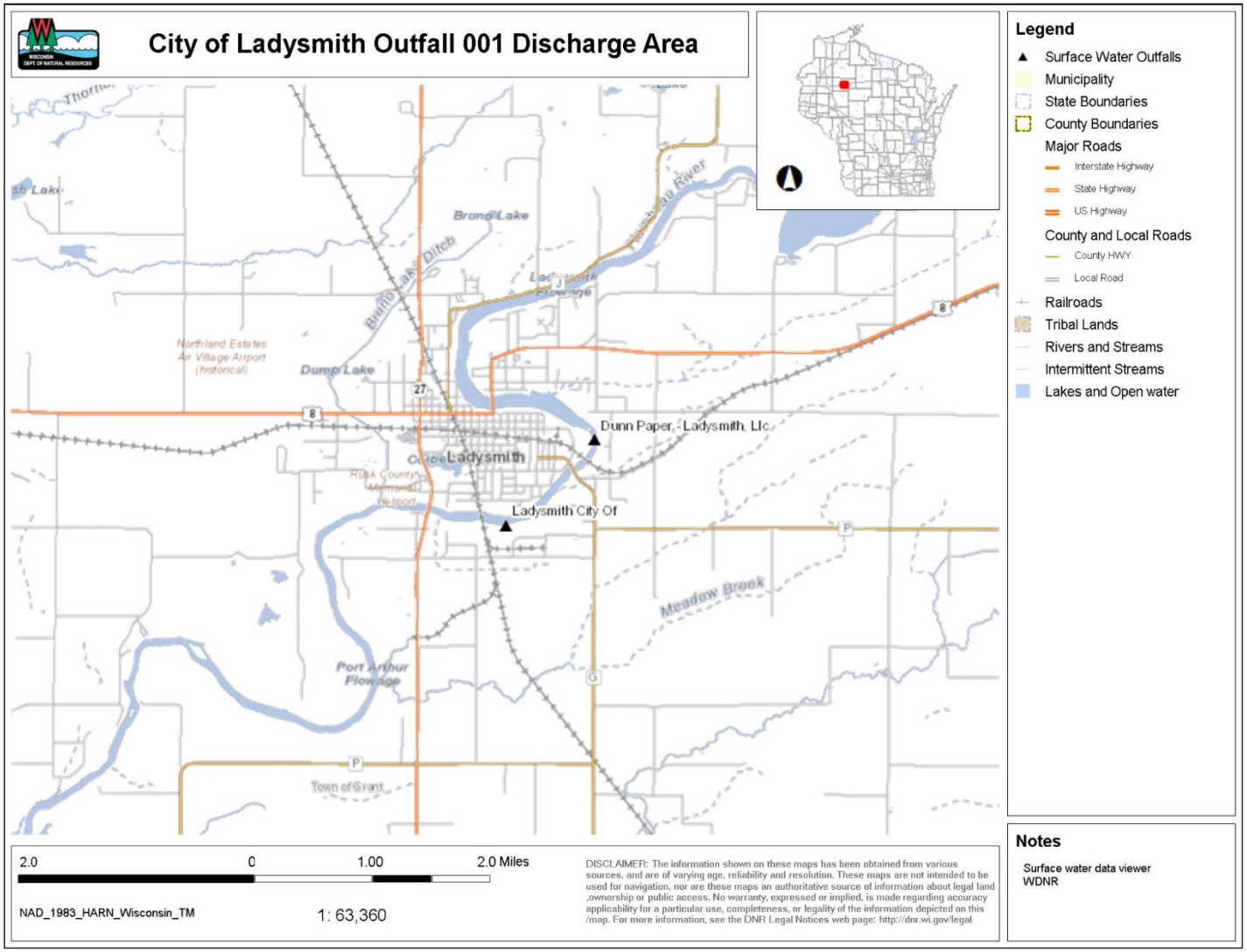
	Acute
AMZ/IWC	Not Applicable. **0 Points**
Historical Data	Five tests used to calculate RP. No tests failed. No acute tests conducted in the last 5 years.

Attachment #1

	Acute
	5 Points
Effluent Variability	Little variability, no violations or upsets, consistent WWTF operations. **0 Points**
Receiving Water Classification	WWSF community. **5 Points**
Chemical-Specific Data	No reasonable potential for limits based on ATC; Ammonia nitrogen limit carried over from the current permit. Chromium, copper, nickel, zinc, and chloride detected. Additional Compounds of Concern: None. **3 Points**
Additives	No Biocides and 2 Water Quality Conditioners added. P treatment chemical other than ferric chloride ($FeCl_3$), ferrous sulfate ($FeSO_4$), or alum used: No. **2 Points**
Discharge Category	No industrial contributors. **0 Points**
Wastewater Treatment	Secondary or better. **0 Points**
Downstream Impacts	No impacts known. **0 Points**
Total Checklist Points:	**15 Points**
Recommended Monitoring Frequency (from Checklist):	Two acute tests during permit term (year 2, 4, 6, etc.)
Limit Required?	No.
TRE Recommended? (from Checklist)	No.

- After consideration of the guidance provided in the Department's WET Program Guidance Document (2019) and other information described above, **2 acute WET tests are recommended in the reissued permit.** Tests should be done in rotating quarters to collect seasonal information about this discharge. WET testing should continue after the permit expiration date (until the permit is reissued).

Attachment #2



Attachment #3

Weekly & Monthly Average Ammonia Nitrogen Limits

AMMONIA (as N) LIMITS	**Ladysmith**	
CLASSIFICATION:	**WARMWATER SPORTFISH**	
EFFLUENT FLOW (mgd):	0.565	
EFFLUENT FLOW (cfs):	0.874	
MAX. EFFLUENT pH (s.u.):	7.80	
BACKGROUND INFORMATION:		
	summer	***winter***
7Q10 (cfs)	412	412
7Q2 (cfs)	709	709
Ammonia (mg/L)	0.04	0.08
Temperature (deg C)	25	3
pH (std. units)	7.73	7.57
% of river flow used:	100	25
Reference weekly flow:	412	103
Reference monthly flow:	603	151
CRITERIA (in mg/L):		
Acute (@ effl. pH):	12.14	12.14
early life stages present	4.40	10.23
early life stages absent	4.40	16.62
early life stages present	1.76	4.09
early life stages absent	1.76	6.65
EFFLUENT LIMITS (in mg/L):		
	summer	***winter***
Weekly average		
early life stages present	**2055**	**1196**
Monthly average		
early life stages present	**1186**	**692**